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USSR PROGRESS IN THE APPLICATION OF PHYSICAL METHODS IN MEDICINE

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The progress of medicine depends on the utilization of the newest achievements in various fields of science. The new achievements of physics and technology are of great importance in perfecting the methods of medical investigation and of the treatment of patients.

Many processes that take place in the organism are due to the participation of insignificantly small amounts of chemical substances and of energy in these processes. This refers particularly to electric processes taking place in such organs and tissues as the heart, brain, stomach, and muscles. For instance, it has been established that the activity of the brain is accompanied by the occurrence of very weak electric currents which have a potential of 1-10 microvolts only. These currents can be detected and recorded with the aid of special equipment, namely oscillographs, the operation of which is based on the application of modern electronics.

Such instruments make it possible not only to record on a film the currents of the brain but also to amplify them to such an extent that they [can be transformed into sound] and heard by an extensive audience. In the near future, electroencephalography will undoubtedly become just as valuable and accessible to practical physicians as electrocardiography.

Extensive possibilities are being opened by the application of photocells in medicine. The action of photocells is based on the photoelectric effect discovered by the Russian physicist E. G. Stoletov. In industry, photocells are being widely applied for signalization and for the automatization of processes which may be very complex and require high precision. This is the reason why photocells are often referred to as electric eyes.

The operation of new and perfect equipment, which enables us to control with great precision the dosage of ultraviolet and solar rays, is based on the use of photocells. Photocells are also used in many other laboratory devices.

The principle of a device designed by Soviet physicists by means of which blind persons can read books and newspapers printed in the ordinary manner is based on the use of photocells. The device in question transforms every letter of the text into a specific sound. Some devices transform the printed letters of a text into a convex sign which can be deciphered by the blind person touching it with his finger.

In connection with the development of electronic optics, the methods of investigation by means of electron microscopes have been considerably perfected and developed. Modern electron microscopes produced in the USSR give a magnification by the factor of 100,000.

With the aid of such supermicroscopes one may see and photograph objects having dimensions of less than 0.1 micron. Such objects are not visible under an ordinary microscope. Pathogenic viruses are objects which have this order of magnitude. Viruses are being investigated at present with the aid of electron microscopes. Photographic pictures of some viruses have been published.

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Of no less interest are powerful impulse X-rays, i.e., X-ray radiation of very short duration. With the aid of such radiation one may obtain clear X-ray pictures after a very brief exposure. Particularly important is the application of impulse radiation in the roentgenography of moving organs, that is of the heart, lungs, and the gastrointestinal tract.

The achievements which resulted from physical and technological progress are being applied in therapy even more extensively than in the field of diagnosis and laboratory investigations.

Electromagnetic waves of various lengths are used extensively in physical therapy. The development of radio techniques and the transition from long waves to short waves and ultrashort waves (waves the lengths of which amount to meters) gave rise to new methods of therapy with the aid of such waves. These methods are known as short-wave diathermy and [the application of] electrical fields of ultrahigh frequency (UVCh).

The State Institute of Physical Therapy in Moscow conducts work on the investigation of still shorter waves, namely waves having a length of the order of decimeters or centimeters. Preliminary data which have been obtained testify to the fact that ultrashort waves of the decimeter range exert stronger biological action than waves of the meter range.

Of great interest is the work of this institute pertaining to the utilization in physical therapy of impulse currents having impulses of diverse forms, duration, and frequencies.

The utilization of direct current impulses of different frequencies and durations in order to bring about sleep is very important from the theoretical and practical standpoints. Electrically induced sleep, like normal sleep, represents a state of inhibition of the cerebral cortex.

At the Institute of Nutrition, Academy of Medical Sciences USSR, positive results have been obtained in the treatment with electrically-induced sleep, of hypertension, of ulcers of the stomach, and of ulcers of the duodenum. At the Institute of Psychiatry, Ministry of Health USSR, and other psychiatric institutions, electrically-induced sleep is being successfully applied for the therapy of some neuropsychiatric diseases.

The achievements of modern illumination technology have enriched physical therapy with new artificial sources of light in the form of various luminescent lamps, used in the therapy of a number of diseases.

Our industry now produces powerful mercury quartz lamps used for ultraviolet irradiation on a mass scale. The role of prophylactic irradiation carried out on a mass scale is particularly important in preventing influenza, angina simplex [sore throat] rickets, and other common diseases.

Wide prospects are being opened up in roentgenology in connection with the possibility of generating ultrashort, very short X-rays by using special equipment that is very powerful, namely synchrotrons. X-rays of this type have a high penetrating capacity. With the use of this radiation, a more advantageous distribution of depth doses is achieved.

The use of radioactive cobalt which emits gamma rays does not require a complex and cumbersome type of equipment. Gamma rays, emitted by cobalt, successfully replace short X-rays in the therapy of many diseases.

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The work carried out by physicists on nuclear fission has led, as is well known, to the production by artificial means of many radioactive elements. The technique of their production, with the aid of special equipment, has been perfected to such an extent that one now may endow with radioactivity a great number of simple and complex substances.

Characteristic property of the artificially obtained radioactive atoms (tracer atoms) consists in their capacity to emit very short rays which are analogous to the rays of naturally occurring radium.

At present, we are able to determine with a great degree of precision the most insignificant quantities of radioactive elements introduced into the human body. This is done by means of devices (counters of tracer atoms) which are being produced in the USSR.

With the use of tracer atoms, the fate of drugs introduced into the organism is being successfully investigated. By using the same method, metabolism is being investigated and pathological processes are being studied in the living body.

For instance, it was possible to establish, with the aid of tracer atoms, that radioactive phosphorus is deposited preferentially in the bones and in the bone marrow. For that reason, radioactive phosphorus is effective in the therapy of diseases of the blood which depend on pathological conditions of the bone marrow. Within several minutes after they have been introduced into the organism, atoms of radioactive iodine concentrate in large quantities in the thyroid gland, exerting a therapeutic effect in that gland.

Ultrasound waves are also used in medicine. If ultrasound vibrations are passed through the body of a human being, they propagate with different velocities in different tissues. For that reason one can use ultrasound to detect foreign bodies hidden in the organism and also tumors, suppurations, and other pathological changes.

When ultrasound propagates through the air it induces precipitation of particles which have been suspended in the air, i.e., dust and smoke particles. Thus, the possibility exists of purifying air by means of ultrasound.

In conjunction with recent work in the field of nuclear physics the possibility has been opened of further supplementing the physical methods of treatment, not only by the application of artificial radioactive substances, but also by using rays composed of particles, namely, electrons, neutrons, and protons.

Streams of nuclear particles, possessing different velocities, may be obtained with the aid of special devices such as cyclotrons, betatrons, etc. Electrons may be easily focused into narrow bundles and directed toward the precise point where their action is needed.

Very little is known as yet with regard to proton rays. It has nevertheless been established that proton rays, like alpha rays of radium which have been thoroughly investigated, have the property of being absorbed readily and intensively in the tissues of the body. Streams of neutrons (both high-velocity and low-velocity neutron rays) are of particular significance for medicine because of their penetrating power. Neutrons may be likened to small bullets which do not have an electric charge and are projected with an unbelievable velocity.

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At present, we are only at the beginning of a major technical re-equipment of Soviet medicine, which is being rapidly enriched with the newest methods of investigation and therapy. The methods in question are important for us, not only from the purely practical standpoint, but also because they will advance the solution of many problems of medicine which are of the greatest importance.

However, the wide penetration into medical practice of the new methods of investigation and therapy is prevented by the slow development of our medical industry. The main fault of the medical industry is that it develops and releases new types of equipment at a rate which is much too slow. For this reason, many of the new methods of investigation and therapy are not yet available to all physicians. The medical equipment and instruments which are being supplied leave much to be desired.

Lack of familiarity with physical methods of investigation and of treatment on the part of physicians is another hindrance to wide application of these methods. Strange as it seems, not a single medical institute has chairs of physical therapy and balneology. The students receive only insignificant information on physical therapy in the course of practical work on internal diseases carried out at faculty clinics.

The Academy of Medical Sciences USSR does not have a special institute of physical therapy in which problems of the application of this form of therapy for prophylactic and therapeutic purposes with the application of new physical phenomena are being studied. The publication of the periodical Fizioterapiya, which existed before the war, has not been resumed as yet.

The facts mentioned above indicate that the new physical methods of treatment and investigation do not receive sufficient attention from the public health organs. The board of directors of the All-Union Society of Physical Therapists and Balneologists is very inactive and lacks initiative.

Medicine is not by any means utilizing all new developments. However, the progress of Soviet medicine must correspond to the progress made in physics, technology, and other branches of knowledge. The government offers to public health units the widest possibilities for that purpose. The workers active at medical institutions must utilize these possibilities in such a manner that the health of the working people will be advanced.

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